NEW YORK, SUNDAY, MARCH 21, 1909, -Copyright, 1909, by the Sun Printing and Publishing Association.

# GREAT LOCOMO-TIVES OF TO-DAY

# fraction History of the Country and Its Vast Developments.

## **ELECTRIC AND STEAM TYPES**

How Both Have Been Perfected in the United States and the Question of Which Will Survive.

increase in Size and Efficiency of Engines | rails of Both Motive Powers Detailed -- Heavy Engines of To-day Mean Best Tractive Values-The Will Take the Place of Steam Power.

in the year 1783 two stages were running between New York and Boston; time consumed in making the journey peared in those days as hazardous as that depended entirely upon the whim of the elements. To-day one may make the The history of locomotive building lies mudhole on the old Boston road.

reight miles of tracks.

the pony express began to make the run 3,000 locomotives in a year. from St. Joseph, Mo., to San Francisco. in 1861 it carried President Lincoln's, call to arms the 2,000 intervening miles in 7 days 14 hours. The country marvelled. The equipment of this mail route included 500 ponies, 190 stations and eighty riders, each of whom covered a lap of thirty-three miles approximately. It cost \$5 to send a letter from St. Joseph to San Francisco.

## A Change in Speed.

weighing 240,000 pounds to-day pull ten and twelve trundling hotels, each filled with passengers. The Union Pacific system, which is only one of several spanning the distance from the Mississippi to the oast, has in place of the 500 ponies 1,088 ocomotives aggregating in weight nearly 0,000 tons. According to the last annual report of that company these locomotives are operated over 5.781 miles of track and the cars owned and leased by the company travelled over 50,440,587 miles.

These cross sections of the history of ransportation in this country illustrate the growth of one of the most potent factors in the industrial, social and economic life of the country and of the world at large. The growth of railroad transportation is necessarily contemporaneous with the growth of the manufacture of ocomotives. The latter factor presupposes the former. It was the perfection of Watt's engine that made possible the pinding of the world into close union.

The locomotive has led the vanguard of civilization and industrial development In the history of this perfection and the record of the part played to-day by the remendous engines now developed lies to a very great degree the history of this country, the census of its present prosperity and the hope for its future.

Even now mechanical genius has sought

to go beyond the limitation of steam as a tractive power, and the harnessing of electricity to the drive wheels of great pulling machines may in future generations be taken to represent the close of the first great epoch in the problem of locomotive transportation and the openng of a new era. Some even go so far as to venture the belief that as the Puffing Billy of the first decade of the last century was the forebear of the four cylinder compound of to-day, so the 150 ton mounlain grade type of electric locomotive that has just been evolved is but the earnest of greater and more serviceable

#### ecomotices of the future. Two Parallel Histories.

The history of the growth of the locomotive in this country is almost contemporaneous with the history of the nation itself Watt completed his engine in 1787 while the Federal Congress was sitting in Philadelphia. Stephenson built his first successful locomotive just as beace after the War of 1812.

first experiment in this country. His Tom Thumb, of a ton's weight and so nervous a machine that the engineer America, the Baltimore and Ohio. Tom Thumb pulled a car that looked like o'clock A. M., and at the above mentioned a mammoth clothes basket and was as hours when the weather is not fair."

devoid of springs as it was full of bumps. It was in 1830 that Peter Cooper brought marvel that had there advanced into the

American inventors had been slower to first grasped the possibilities inherent in the crazy, rattletrap machines that were ploughing over strap iron in the old country they forged ahead and began tinkering with steam locomotives of their own devising, without ever attempting to copy the models set up by the Englishmen.

In 1832 Cooper had turned out another engine, the Traveller, he called it. All the locomotives of the early days were given high sounding names like ships, because possibly there were so few of them. This Traveller was of what the experimenters then dubbed the "grass-hopper type." It had straddling walking pleted in June, 1834. It weighed 17,000 beams that kicked out to the rear in a most fantastic manner. But it went, and that was the most important thing. The Rogers Beginning.

After Wilson Eddy, William Mason and turned out experimental machines which of this engine known as the Lancaster. ometimes ran and sometimes did not the first attempts at locomotive building for the market began. Thomas Rogers, a Connecticut man who had been trained as a carpenter and who later became one of the partners in a machine making firm. devised a locomotive and then he formed a company to turn out engines for the

It was in 1835 that the concern of Rogers, Ketchum & Grosvenor started in a business which has since grown to be one Greater Worth as Haulers, but Make of the great locomotive manufacturing companies of the country. The Sandusky, their first engine, had cylinders 11x16 inches placed under the smokebox. tures by Great Railroads to Obtain transmitting the power to the cranked axle of a single pair of driving wheels, which were placed in front of the firebox. the Future Declared The front end of the locomotive was to Be Whether or Not Electricity supported by a four wheel truck with four 30 inch wheels.

This Sandusky was a success. Immediately orders began to come in from newly organized railroad companies for more of the type, and the company of they accommodated all the passengers which Rogers was the leading spirit and who desired to make the trip, and it was master inventor found itself suddenly tacitly understood that the length of fully launched upon a business that ap-

trip between the two cities in the time in the history of the pioneer companies that it used to take the stage driver and that dared to attempt the making of passengers to lift their vehicle out of a an inventor's plaything-in some cases an inventor's nightmare it was-into In the year 1908 there were 58,301 loco- something really a tangible, solld busimotives in the United States, running ness proposition. The early successes over 324,033 miles of steel and doing the the temporary failures, the constant work for millions that the horses on the striving after perfection in what was even Foston-New York and other stages used then a complicated machine that marked to do for a few hundred. These loco- the efforts of these pioneer manufacmotives pulled 860,648,574 people over turers is illustrated fully in the record 511,579,317 passenger miles, and in the of the establishment founded threesame year they took 1,722,210,281 tons of quarters of a century ago by Matthias the country's freight over 645,477,465 W. Baldwin of Philadelphia—an establishment which after many vicissitudes

## Baldwin's Progress

Matthias W. Baldwin got his start in life as a jeweller in 1817. A few years after that he owned a small shop and ran the business on his own accourt. Later he constructed a small stationery engine for a manufacturing firm, and such a success did he make of his stationary engine that later he allied himself with several other men and opened a machine shop. In 1829 the use of steam for motive To-day the mail goes across the continent from ocean to ocean in ninety-five hours. Where the pony express used lic interest a Mr. Franklin Peel, propriarie, locomotives prietor of the Philadelphia Museum, the tracks of wood with steel straps laid locomotive for exhibition in his estab-

With only the imperfect published descriptions of the locomotives that were taking part in a then famous competition in England Mr. Baldwin went to work and in April, 1831, he completed a miniature locomotive that was put in motion on a circular track made of pine strips in the rooms of the museum. Two small cars were attached to the locomotive, sufficient for four passengers, and the novel spectacle attracted crowds of admiring spectators. That same year Mr. Baldwin received an order for a locomotive of the type of his model from the Philadelphia, Germantown and Morristown Railroad Company, which ran a line of six miles to Germantown and which, up to that time, had been operated by horse power. Mr. Baldwin went to work, and in 1852 he produced his engine Old Ironsides, one of the now famous relics of the early age of locomotive engineering.

The Ironsides was a four wheel engine with rear driving wheels 54 inches in diameter. The front wheels, which were simply carrying wheels, were 45 inches in diameter on axles placed just back of the cylinders. The cylinders were 91/2 inches by 18 inches and were attached horizon tally to the outside of the smokebox. The boiler was 30 inches in diameter and contained seventy-two copper flues 11/2 inches in diameter and 7 feet long. The engine had no cab.

The price of this unique locomotive was \$4,000 and its inventor had difficulty in getting his money, the company contending that the engine did not perform according to contract. When this engine was making its first trip to Germantown one of the engine drivers slipped upon the axle, causing the wheels to track less than the gauge of the road and to drop in between the fails. It was also discovered that the valve arrangement of the pumps was defective and that they failed to supply the boiler with water. The shifting of the driving wheels upon the axle threw out the eccentric so that it would not oper-

# ate in backward motion

Old Ironsides Ran, Anyway All in all, Old Ironsides was a very tender toy. Nevertheless it attracted wide england and America were sealing a attention and the Philadelphia, Germantown and Morristown Railroad got out "locomotive engine" appeared in large type. This handbill notified the interetsed public that the "locomotive engine preferred to walk along the side of it built by Mr. M. W. Baldwin will depart when it was in operation, was first run daily when the weather is fair with a train over wooden rails covered with strap of passenger cars from Philadelphia at owned by the first railroad company in horses will also depart from Philadelphia

It must not be understood that this announcement intended to say that in wet out his Tom Thumb. People were being weather horses would be attached to the blown up occasionally over in England locomotive to aid in drawing the train, and hiled with excitement over the new nevertheless the suspicion might be model, now generally adopted and known voiced that occasionally horses would

take up with the new idea, but when they it is related of him that his discouragement at the difficulties which he had undergone in building it and in finally receiving a settlement for it caused him to remark to one of his friends: "This is our

last locomotive." Nevertheless the inventor evidently regained his confidence again, because shortly afterward the Commonwealth of Pennsylvania gave the Baldwin Loco-Philadelphia to Columbia, which up to that time was worked by horses. This pounds. Its feat in carrying nineteen loaded cars over the highest grade be-tween Philadelphia and Columbia was characterized at the time by the officers of the railroad as an unprecedented per-George S. Griggs had each in his peculiar formance. Five locomotives were comway tinkered with the locomotive and had pleted in that year, all after the type A Coal Burner.

6000

to give here the general characteristics the beginning of the civil war

A four driving wheel, four wheel truck, the latter being expanded by the addition of an extra number of driving wheels, weighed from 55,000 to 80,000 pounds, and strange as it may seem made as good speed as it made to-day. One of these engines of a more advanced type motive Works an order for a locomotive even made eighty-five miles an hour. for the State road, as it was called, from That was in the year 1878, but with the increase of weight and the carrying capacity the demand for an increased locomotive power made the builders of locomotives enter upon an era of heavy engines. That was forty years ago and they have been building them heavier ever since.

Baldwin's famous fast passenger en-

TOP WEIGHT AND SIZE IN ELECTRICS

turers in New Jersey and Connecticut applying a lever the weight on the drivers weight of the locomotive is on the driv-

were following out their own lines in this could be increased and about 24,000 ing wheels, giving a tremendoue tractive new field of locomotive construction, pounds of weight on the wheels in front power.

A speed of four miles in three minutes

going under the boiler was one of the present the perfection of the locomotive diameter; its low pressure cylinders 39

difficulties of the early engineers. How- has been so rapid, so various in its many inches, and each has a stroke of 28 inches.

the consumption of coal on the German- cated that a casual observer cannot but and its weight is borne partly upon this

town road, and he devised a fanlike ar- note the various types of engines which and partly upon the forward radial frame,

Other American Types.

wheels, four wheeled trucks in front

and two trailing wheels to help support

190,000 pounds. As large a driving wheel

as eighty-four inches has been manu-

factured, but the average is sixty inch

a great speed on a level, but it was not

a hill climber, and because of the unequal

distribution of the weight on the rails

it was, in railroad parlance, a track killer.

The class of engines known as Moguls.

with three pairs of drivers in a swinging

Baldwin establishment, and afterward

became through many modifications

N.Y.C. - & H.R.

Mr. Baldwin was busy in perfecting his of the fire box became correspondingly

even secured a patent for an engine grate gines, and on one occasion President Tay-

which could be detached from the engine lor was taken in a special train over the

at pleasure and a new one with fresh Pennsylvania Railroad lines in one of

ever, this patent was never put into effect. manifestations and in the interior work-

rangement to keep the fire going. At have been evolved from the original

At this time Henry R. Campbell made a the weight of the boiler. The highest

great stride in locomotive construction weight of this engine reached about

motive which was not slippery. In other drivers. This engine was found to attain

locomotive, in other words a locomotive pony truck in front, took its rise in the

momentous events in American locomo- a favorite freight engine for several

that time the modern draught system in American type of the ante-bellum days.

In 1838 Mr. Baldwin experimented with ings of the machine that is so compli-

fire substituted. This would seem these machines at the rate of sixty miles

machine and in three years he became reduced.

interested in the burning of anthracite

locomotives was unknown and the jig-

gling of the locomotive as it passed over

ipon them made it hard enough for the

engineer to keep his seat, to say nothing

when he produced his first locomotive

with two driving wheels. Up to this time

it had been very difficult to make a loco-

words, locomotives were not heavy

enough to make any progress on the

tracks and too often the wheels spun

around madly while the locomotive was

moving inches instead of yards, and Henry Campbell's invention of the 4-4-0

with four driving wheels and four wheels

on the forward truck, was one of the most

tive building. The engine lacked, how-

There were no equalizing wheels

ever, one essential feature.

about the fire keeping its place

decade of the last century.

Three of these engines are now doing design. pushing work on the Erie Railroad over what is known as the "Summit" on the of these engines it had formerly required bination freight locomotives of the highest power the services of from two to four pushers to negotiate this grade.

The new engines, one of which is shown in the picture accompanying this article, be adequate to do the work required. are performing this work satisfactorily and overcoming all the difficulties that their designer prophesied they would.

The tractive effort of these leviathans mong locomotives working compound is 94,800 pounds and working simple 116,gine of 1848 had cylinders fourteen by 000 pounds, which is some 25,000 pounds twenty and six foot driving wheels. They more than any locomotive hitherto conweighed each about 47,000 pounds, distructed. The engine weighs 410,000 tributed as follows: 18,000 on the drivers, pounds, is 23 feet 5 inches in length and 14,000 on the pair of wheels in front of carries two sets of eight driving wheels. While other inventors and manufact the fire box and 15,000 on the truck. By There being no carry trucks, the entire

larger than any in existence. This boiler

This boiler is mounted rigidly upon the

main or after frame of the locomotive

on the front end of which the low pressure

plate and other devices on which the

boiler rests allowing it to do this with

comparatively little resistance. In fact,

by reason of the flexibility of the wheel

base the lateral wrenching effects of this

engine upon curves is materially less

Could Haul 250 Cars.

favorable conditions and with the loco-

motive working at its highest possible

power it could haul on a level a train of

The train itself would be approximately

two miles in length and the speed po s-

sible under such conditions would be from

The boiler tubes ar3 404 in number

eight to ten mi es an hour.

loaded freight cars of 40 tons capacity.

than in the ordinary type of engine.

It is estimated that under the

cylinders are mounted.

The first development was the Atlantic or left as the case may be, the steel bear-

years. In the passenger type of engine 2% inches in diameter, 21 feet in length

the Atlantic type in its turn gave way and have a heating surface of 4,971 square

to the Pacific type about five or six years, feet, the steam pressure being 215 pounds.

6000

second stage of experimentation. The help the locomotive over a grade. Such the ideal engine for hauling both passen- with wheat would represent a tract of lated engine would have been the last. was Mr. Baldwin's first locomotive and ger and freight trains. It might be well twenty-six miles of wheat land. That Under existing conditions, however, a then is the last word in the history of the certain amount of complication is essenof the American type as it stood about development of Puffing Billy of the fourth tial, and in many cases simplicity must be sacrificed in order to secure a satisfactory

> "The restricting conditions of the present day include stability of roadbed. Susquehanna division. Without the use weight of rails, grades, curves, speed required and amount of load to be hauled; in addition to the hauling power of com- also gauge of track and the limit of height and width through which the train must pass. The problem before the designer is to construct a locomotive which will conform to these conditions and also

> > "Modern ideas of economical railroad are restricted as to size and hauling ca- new surveys. pacity by the conditions already named.

"Were increased weight the only essential in providing more powerful locomotives, heavier rails could be used and the stability of the permanent way increased. As, however, locomotives are Gap and Truckee. The building of this part of the designer's problem is to make make this outlay a guarantee of future provision for such increase: Each ad- economy ditional horse-power requires additional heating surface and grate area, and thus the boiler must be larger and occupy more space. This increased space must

#### New Difficulties.

"This was a comparatively easy proposition when boilers were small in diameter and set so low that an imaginary line drawn on the cross section from the boiler centre to the points of contact between the wheels and rails would form the boundary of a triangle in which the sides would be nearly equal. In recent practice the height of such a triangle has increased to more than twice its base, and the boiler instead of being entirely between the wheels is on account of its increased diameter placed above them. On 'standard,' or 4 feet 81/4 inch. gauge roads boilers 7 feet in diameter have been placed 10 feet from top of train miles, all mixed train miles and helprails to centre of boiler, and the centres of 42 inch boilers on roads of 2 feet gauge have been placed 5 feet above the rails. Were lines drawn from the centres of boilers so located to the gauge line at the rails they would form angles of only 131/2 and 111/2 degrees respectively."

On the subject of the increased weight of locomotives in the last few years Prof. William Z. Ripley wrote to the Railroad Age Gazette a few months ago:

"The average weight of locomotives at the end of the civil war was 90,000 To supply the steam necessary to move pounds. This has increased in somewhat such an enormous mass of metal and to the following ratio: To 1881, 102,000 pounds; enable it to do the work required of it to 1893, 135,000; to 1895, 148,000; to 1898, Here is another comparison: In 1859 now employs 19,000 men and can turn out coal. Strange as it may seem now, he was once recorded for one of these en- it was necessary to design a boiler far 230,000, rising in 1900 to 250,000." His figures were subsequently contradicted weighs 100,000 pounds and with its weight by persons who did not, however, supply of water 140,000 pounds, and has a heat- tables of their own, and an official of the ing capacity of 5,314 square feet. Its Erie Railroad told THE SUN man that he to indicate that the keeping of the fire an hour. From this time on until the high pressure cylinders are 25 inches in believed tnem to be in the main correct.

#### How Weights Have Increased. Another authority in the railroad world

has put the increase in the weight of locomotives this way: From 1902 to 1907 the increase in the

weight of the heaviest engines has been over 200,000 pounds, or about 95 per cent. The increase in the average passenger This mounting enables the locomotive engine is over 90,000 pounds, or about when it strikes a curve to swing to right 70 per cent. For ordinary freight engines The works turned out its one thousandth the increase in weight has been 90,000 pounds, or 60 per cent. The ordinary passenger engine now in use is heavier than the heaviest freight engine of ten years ago, and it weighs just twice as much as the average passenger engine of fifteen years ago."

The pulling capacity of the modern engine has increased marvellously over that of the engines of a decade ago. That of the modern freight engine of the 355,000 pound type, for example, has increased 200 per cent. over the traction powers of the freight engine of the middle '60s.

"On a level track the modern freight engine will pull as many cars as will hold together," said the Erie official quoted above. "At the same time the freight canacity of the cars has increased from 10,000 pounds to 80,000 in box cars and from 10,000 to 100,000 pounds in coal cars, the Union Pacific Company had in service the latter 100 per cent., increase being upon all its lines 1,088 engines of all variedue to the introduction of the steel gondola car.

of locomotives and the capacity of freight of operating expenses included in the recarriers is just this: In former times an port record is made of what it costs to 80,000 pound engine would haul twentyfive cars of 30,000 pounds capacity, say; ning condition. to-day the average 240,000 pound locomotive in freight service will haul fifty cars shops footed up to \$3,221,699.41 during the of 100,000 pounds capacity. The ratio of course of the year and to this was added increase is geometrical. The trackage \$40,038.98 spent for renewals. These steel capacity of American railroads to-day is trebled, even quadrupled, over that of Union Pacific just \$6,587,582.87 in one year thirty years ago."

# Other Considerations.

The tremendous increase in the weight and length of the locomotives being manufactured to-day, the heightened speed at which they run, the increased weight of loads that they haul-all these elements have combined to bring about new and difficult conditions in the matter of the roadbed and the maintenance of way. These latter considerations arise naturally as the corollaries of the problem of ininches long, 9 feet 6% inches in width, creasing the traction power of the locomotives.

An engaine of the old Atlantic type, 190,000 pounds of weight, drawing a freight train of twenty-five cars may have run the rails is 15 feet 5% inches. The drivers over the old roadbeds with their small rails without danger to the train or damage to the rails, but a high power locomotive weighing \$50,000 pounds and drawing a train of fifty cars, each of a capacity double that of the old cars, cannot pass over these tremendous locomotives of the those rails with the same immunity. present day have increased almost in Heavy rails are rapidly supplanting the

lighter ones on all the big roads.
Since it is economy for the railroad companies to utilize one big engine that will draw a heavy load instaed of two smaller ones pulling lighter loads the roadbed itself has to be strengthened, reenforced by ballast and more heavily spiked. Then there is the matter of tial factors in the scheme of railway loop grades and curves to be considered. Inder the heavy load-the maximum they be of the flexible type, curves have

The amount of alteration work that is being done on all of the railroads carrying

heaviest type of locomotives has become enormous during the last five years 0 the Erie and Pennsylvania systems in the East as well as on the New York Central system there is progress in the task of making the roadbed and the grade fit new conditions.

#### Greater Work in West.

In the West the work of making new roadways to accommodate the giants of the locomotive shops has taken even a more general course and required a greater outlay. James J Hill was the one who first saw the necessity and realized the great economy of changing the contour and character of his roadbeds on the Great Northern. The 2.2 grades beoperation demand the use of the fewest tween Leavenworth and Cascade tunnel possible number of trains to handle the and a grade of the same degree between raffic. The weight of trains on almost Lexington and Bozeman tunnel have both all roads is limited by the hauling ca- called for heavy work in altering the pacity of the locomotives, which in turn lines and in seeking easier ascents along

In California E. H. Harriman has undertaken the construction of a great tunnel through the crest of the Sierras on his Southern Pacific line which will reduce increased in power they must also be in- tunnel will be the work of years, but the creased in size, and the most difficult exigencies of present day freight traffic

Tables on the average train load and tons a loaded car that have passed over the lines of the Union Pacific between the years 1898 and 1908 are given in the last be provided within the limits of the load-ing gauge show graphically and conclusively why it is that roadbeds of fifteen years an cannot stand the traffic of to-day and also they mark the great increase in the size of train loads following the rogress of the locomotive. The table may be sum marized thus, the average train load being the standard of measurement:

c n u e t r a in mile...280 310 310 370 420 400 450 510 510 480 510 per loc-o m o-t i v e mile...220 230 280 310 370 350 380 450 450 430 480

Revenue train miles include miles run with freight trains and all mixed trains. Locomotive miles include revenue freight ing freight miles

#### Capacity Figures.

A second table included in the last annual report of the Union Pacific supplements the one given above in that it sh the steady increase in the capacity of the freight cars, commensurate with the increased pulling powers of the locomotives used by the road. This table, given roughly according to diagram, is as

ons per loaded car...13.5 16 17.5 18 19 19 21 22 22.5 22.6 2 Every locomotive manufacturing concern has data giving the figures on the great increase in production during the last fifteen years. To such great lengths has the business of turning out the steel horses of the rails gone that to-day the works produce them like sewing machines, so many per day. In the '30s it was a matter of months over one engine. As fairly typical of the production of the American Locomotive Company and other concerns engaged in the business some figures from the accounts of the Baldwin Locomotive Works may be cited to show

sandth was completed in the year 1907 The following table shows the fluctuation in the production of locomotives by this firm, taken as an example during certain periods in the history of transportation in this country, due to influencing causes of financial depression and the instability of the railroads in certain years:

Production during the years 1872-1906 Locomotires.

# .422 .437 .205 .130 .232 .185 .292 .298 .517

# Repair Bills of the U. P.

During the year ended June 30, 1905. ties, an increase of thirty-seven, or 3.52 per cent, over the number possessed "The result of this increase in the power during the previous year. In the item keep over a thousand locomotives in run

The repairs upon them in the machine train pullers ate up coal that cost the they needed \$88,516 worth of oil to lubricate their joints. The entire cost of the locomotive service, over all. was \$10,-515,164 in round numbers.

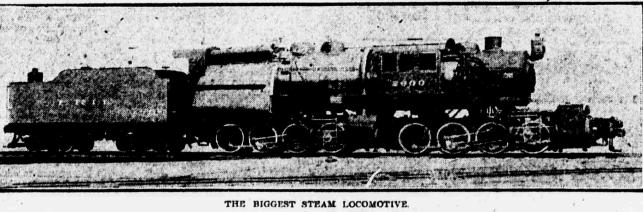
To continue tracing just what part the locomotives play in the net earning power of a great railroad system, it may beoited that all the lecomotives on all the lines of the Union Pacific system during the fiscal year 1908 pulled 6,450,286 pass who paid their fares, to say nothing of brakebeamers unspecified, over an average distance of 117.91 miles each or, reducing the figures to a unit, the looomotives of the Union Pacific carried 760,532,906 persons one mile.

Those same locomotives carried during the year 17,888,017 tons of freight, including that owned by the company. The revenues derived from the transports tion of passengers amounted to \$16.641,-67.67; of freight, \$52,899,157.66.

# Electric Locomotives.

Just as the steam locomotive of early '30s rapidly passed out of the est perimental stage and began to assume the position of chief factor in one of the greatest phases of the nation's industrial development, so has the electric locome tive emerged from the preliminary stage of doubtful experimentation and I within the last few years one of the noten motion.

There is now no longer any doubt of load it nearly always is—grades have to the efficiency of the electric locomotive be reduced where possible, and with the in a field which is as yet necessarily someengines of great length, even though what limited; its chief exponents maintain that the limitations on this field must soon be swept away and the electric loco must eventually be considered more efficient than the steam engine now estabheavy freight and necessarily using the lished by custom and railway usage as the



tween the drivers and nothing but the ago. This is a 4-6-2 engine possessing The total wheel base of the engine and ordinary steel springs over each journal over the Campbell engine was introduced greatest. the following year by Eastwick and Harrison, another Hercules. This engine had equalizing beams between the driving wheels, the invention of Harrison, Jr. This was an important invention and by degrees worked into universal adoption.

Baldwin meanwhile, not agreeing with the Campbell theory, had tried to mountainous. The early eight wheel secure more adhesion of the engine on the rails by turning out a gear engine. He patented the gear engine, but the type failed of his anticipations after several It was Peter Cooper who ventured on an attractive handbill in which the words trials and it was definitely abandoned. The engine as it stood at this time marked the turning point in the construction of locomotoves. For the first forty years of railroad operating the dominating aim of been to produce locomotives suitable for iron on what was then the first bit of track 11, 1 and 3 o'clock. The cars drawn by all kinds of service, one that would be fairly efficient and durable enough to The at 9 o'clock and from Germantown at 10 make long runs with small expense for repairs and subject to few failures.

The American Type. Except on the comparatively few railroads handling minerals and other heavy freight over steep grades the eight wheel

as the terminology shows, two more of the driving axles to equalize the weight drivers than were possessed by the Atupon them. A very decided improvement lantic and weighing 231,000 pounds at the The driving wheels of this engine are

from seventy-four to eighty-six inches in diameter. Since the weight is more of 1/4 inch steel. thoroughly equalized on the rails than that of the preceding type this engine has become almost the uniform type for traffic in all localities not excessively freight engine of the civil war times and the decade immediately afterward gave place to ten wheels and then to twelve, the latter being known as the Consolidation type. The average type used is the Consolidation 240,000 pounds weight for general service

machine used for heavy grades largely the Mallet articulated compound locoinventors and locomotive builders had in the Western States. For pulling motive set forth the hampering restriccapacity the modern freight engine has been increased 200 per cent. the last twenty-five years.

The Greatest Steamers. So the progress of invention and of manufacture has developed from the early days of the Sandusky and the Tom

tender is 701/2 feet, that of the engine itself being 39 feet 2 inches. The firebox, of the Wooten type, is 10 feet 61/2 of tube sheet steel, 1/2 inch in thickness, with the sides, back and crown sheets The height of the smokestack above

of this engine are, of course, small as compared with many engines of the Pacific type, measuring only 51 inches in dia-

The difficulties faced by the builders of the same ratio as their size. Grafton Greenough, a well known construction engineer, in addressing the Engineers The Mogul Consolidation type is a 4-12 Club of Philadelphia upon the type of tions of road gauge, instability of roadbed, &c., which the designers of the high power locomotive must overcome. He said:

# Simplicity Is Best.

"It is almost an axiom that within limiting conditions the simplest devices Thumb down to the present time, when are the best, and to this the locomotive the largest engine on the road to-day is no exception. If the railroads were so locomotive-that is to say, Campbell's is one which on a level could haul a constructed and operated that the simtrain of 250 loaded freight cars each of plest forms of engines would suffice,

to be reduced.

as the American type-was regarded as forty tons capacity, which cars if loaded it is logical to infer that the first articu-